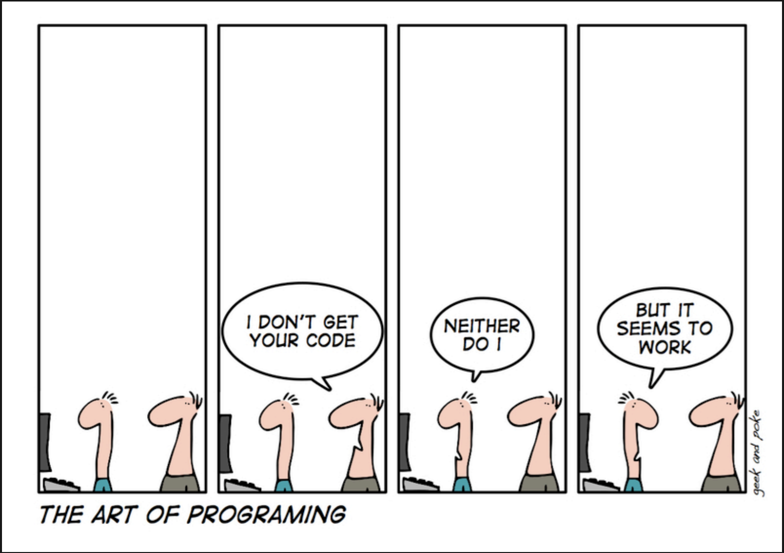

geekandpoke.typepad.com

Writing clear code

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Basic principles

- Code that works

  No bugs; efficiency is secondary (or tertiary)
- Readable

  Fixable; extendible
- Reusable

  Modular; reasonably general
- Reproducible

  Re-runnable
- Think before you code

  More thought $\Longrightarrow$ fewer bugs/re-writes
- Learn from others' code

  R itself; key R packages

Write programs for people, not computers

Wilson et al. (2014) PLoS Biol 12:e1001745

Break code into small functions

```
get_grid_index <-
function(vec, step)
{
  grid <- seq(min(vec), max(vec), by=step)
  index <- match(grid, vec)

  if(any(is.na(index)))
    index <- sapply(grid, function(a,b) {
      d <- abs(a-b)
      wh <- which(d==min(d))
      if(length(wh)>1) wh <- sample(wh, 1)
      wh
      }, vec)

  index
}
```

Break code into small functions

```r
sampleone <-
function(vec)
  ifelse(length(vec)==1, vec, sample(vec, 1))

get_grid_index <-
function(vec, step)
{
  grid <- seq(min(vec), max(vec), by=step)
  index <- match(grid, vec)

  if(any(is.na(index)))
    index <- sapply(grid, function(a,b) {
        d <- abs(a-b)
        sampleone(which(d == min(d)))
      }, vec)

  index
}
```

Clarity over efficiency

```
sampleone <-
function(vec)
  ifelse(length(vec)==1, vec, sample(vec, 1))

get_grid_index <-
function(vec, step)
{
  grid <- seq(min(vec), max(vec), by=step)
  index <- match(grid, vec)

  if(any(is.na(index))) {
    for(i in seq(along=grid)) {
      d <- abs(grid[i] - vec)
      index[i] <- sampleone(which(d==min(d)))
    }
  }

  index
}
```

One last change

```
sampleone <-
function(vec)
  ifelse(length(vec)==1, vec, sample(vec, 1))

get_grid_index <-
function(vec, step)
{
  grid <- seq(min(vec), max(vec), by=step)
  index <- match(grid, vec)

  missing <- is.na(index)

  if(any(missing)) {
    for(i in which(missing)) {
      d <- abs(grid[i] - vec)
      index[i] <- sampleone(which(d==min(d)))
    }
  }

  index
}
```

Another example

```
# rmvn: simulate from multivariate normal distribution
rmvn <-
function(n, mu=0, V=diag(rep(1, length(mu))))
{
  p <- length(mu)

  if(any(dim(V) != p))
    stop("Dimension problem!")

  D <- chol(V)

  matrix(rnorm(n*p),ncol=p) %*% D + rep(mu,each=n)
}
```

Further examples

```
# colors from blue to red
revrainbow <-
function(n=256, ...)
  rev(rainbow(start=0, end=2/3, n=n, ...))



# move values above/below quantiles to those quantiles
winsorize <-
function(vec, q=0.006)
{
  lohi <- quantile(vec, c(q, 1-q), na.rm=TRUE)
  if(diff(lohi) < 0)
    lohi <- rev(lohi)

  vec[!is.na(vec) & vec < lohi[1]] <- lohi[1]
  vec[!is.na(vec) & vec > lohi[2]] <- lohi[2]

  vec
}
```

Writing functions

- Break large tasks into small units.
  - Make each discrete unit a function.
- If you write the same code more than once, make it a function.
- If a line/block of code is complicated, make it a function.

Don’t repeat yourself (or others)

- Avoid having repeated blocks of code.
- Create functions, and call those functions repeatedly.
- This is easier to maintain.
  - If something needs to be fixed/revised, you just have to do it the one time.
- Look at others’ libraries/packages.
  - Don’t write what others have already written (especially if they’ve done it better than you would have).

Don’t make things too specific

- Write code that is a bit more general than your specific data
  - Don’t assume particular data dimensions.
  - Don’t forget about the possibility of missing values (even if your data doesn’t have any).
  - Aim for re-use.
- Use function arguments
  - Don’t assume particular data file names
  - Don’t hard-code tuning parameters
  - R scripts can take command-line arguments:

```
Rscript myscript.R input_file
output_file
args <- commandArgs(TRUE)
```

No global variables, ever!

- Don’t refer directly to objects in your workspace.
- If a function needs something, pass it as an argument.
- (But what about really big data sets?)

No magic numbers

- Name numbers and use the names

```
max_iter <- 1000
tol_convergence <- 0.0001
```

- Even better: include them as function arguments

Indent!

```r
# move values above/below quantiles to those quantiles
winsorize <-
function(vec, q=0.006)
{
lohi <- quantile(vec, c(q, 1-q), na.rm=TRUE)
if(diff(lohi) < 0)
lohi <- rev(lohi)
vec[!is.na(vec) & vec < lohi[1]] <- lohi[1]
vec[!is.na(vec) & vec > lohi[2]] <- lohi[2]
vec
}
```

Use white space

```
# move values above/below quantiles to those quantiles
winsorize<-function(vec,q=0.006)
{lohi<-quantile(vec,c(q,1-q),na.rm=TRUE)
if(diff(lohi)<0)lohi<-rev(lohi)
vec[!is.na(vec)&vec<lohi[1]]<-lohi[1]
vec[!is.na(vec)&vec>lohi[2]]<-lohi[2]
vec}
```

Don’t let lines get too long

```
get_grid_index <-
function(vec, step)
{
  grid <- seq(min(vec), max(vec), by=step)
  index <- match(grid, vec)

  if(any(is.na(index)))
    index <- sapply(grid, function(a,b) { d <- abs(a-b); sampleone(whi

  index
}
```

Use parentheses to avoid ambiguity

```
if( (ndraws1==1) && (ndraws2>1) ) {

 ...

}

leftval <- which( (map - start) <=0 )
```

Names: meaningful

- Make names descriptive but concise
- Avoid `tmp1`, `tmp2`, ...
- Only use `i`, `j`, `x`, `y` in the simplest situations
- If a function is named `fv`, what might it do?
- If an object is called `nms`, what could it be?
- Functions as verbs; objects as nouns

Names: consistent

- `markers` vs `mnames`
- `camelCase` vs. `pothole_case`
- `nind` vs `n.var`
- If a function/object has one of these, there shouldn't be a function/object with the other.

Names: avoid confusion

- Don't use both `total` and `totals`
- Don't use both `n.cluster` and `n.clusters`
- Don't use both `result` and `results`
- Don't use both `Mat` and `mat`
- Don't use both `g` and `gg`

Comments

- Comment the tricky bits and the major sections
- Don’t belabor the obvious
- Don’t comment bad code; rewrite it
- Document the input/output and purpose, not the mechanics
- Don’t contradict the code
  - this happens if you revise the code but don’t revise the related comments
- Comment code as you are writing it (or before)
- Plan to spend 1/4 of your time commenting

Error/warning messages

- Explain what's wrong (and where)
  - `error("nrow(X) != nrow(Y)")`
- Suggest corrective action
  - `"You need to first run calc.genoprob()."`
- Give details
  - `"nrow(X) (", nrX, ") != nrow(Y) (", nrY, ")"`
- Don't give error/warning messages that users won't understand.
  - `X'X is singular.`
- Don't let users do something stupid without warning
- Include error checking even in personal code.

Check data integrity

- Check that the input is as expected, or give warnings/errors.
- Write these in the first pass (though they're dull).
  - You may not remember your assumptions later
- These are useful for documenting the assumptions.

Program organization

- Break code into separate files (say 300 lines?)
- Each file includes related functions
- Files should be named meaningfully
- Include a brief comment at the top.

Create an R package!

- Make a personal package with bits of your own code
- Mine is R/broman, `github.com/kbroman/broman`

```
# qqline corresponding to qqplot
qqline2 <- function(x, y, probs = c(0.25, 0.75), qtype = 7, ...)
{
  stopifnot(length(probs) == 2)
  x <- quantile(x, probs, names=FALSE, type=qtype, na.rm = TRUE)
  y <- quantile(y, probs, names=FALSE, type=qtype, na.rm = TRUE)
  slope <- diff(y)/diff(x)
  int <- y[1L] - slope*x[1L]
  abline(int, slope, ...)
  invisible(c(intercept=int, slope=slope))
}
```

Complex data objects

- Keep disparate data together in a more complex structure.
  - lists in R
  - I also like to hide things in object attributes
- It's easier to pass such objects between functions
- Consider object-oriented programming

Avoiding bugs

- Learn to type well.
- Think before you type.
- Consider commenting before coding.
- Code defensively
  - Handle cases that ”can’t happen”
- Code simply and clearly
- Use modularity to advantage
- Think through all special cases
- Don’t be in too much of a hurry

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- Think before you code

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  R itself; key R packages

Summary

- Get the correct answers.
- Find a clear style and stick to it.
- Plan for the future.
- Be organized.
- Don’t be too hurried.
- Learn from others.